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Research Article

STEAM-BASED PRINCIPLES AND PROCESS OF DESIGNING GAMES FOR PRESCHOOL CHILDREN BETWEEN 5-6 YEARS OLD IN HO CHI MINH CITY

Nguyen Thi Kim Anh[1*], Nguyen Thi Thanh Binh[2], Nguyen Thi Thanh[3]

[1]Institute of Education Science and Teacher Training, Hong Bang International University, Vietnam
[2]Institute of Research and Development Education and Economic EXIM, Vietnam
[3]Ho Chi Minh City University of Education, Vietnam
[*]Corresponding author: Nguyen Thi Kim Anh – Email: anhntk2@hiu.vn
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ABSTRACT

STEAM (Science, Technology, Engineering, Arts and Mathematics) Education has gained increasing attention over the past decade for K12 education. This article analyzes basic concepts including the principles and process of designing games. In this research, six principles in designing game structures with a STEAM approach are illustrated: purposeful, comprehensive, developmental, aligned with the structure and characteristic properties of the game, and diversified and popular. At the same time, the article outlines the step-by-step process of designing games for preschool children between 5-6 years old with the STEAM approach. Based on this, teachers will be able to design games with a STEAM approach for preschool children between 5-6 years old more efficiently and appropriately according to real-life conditions.

Keywords: game design with a STEAM approach; principle; process

1. Introduction

Early Childhood Education Program in Vietnam according to the Consolidated Document in January 2017 to form and develop children's appropriate skills, capabilities, and competencies, creating a solid foundation to help children become confident and ready for the transition to primary school, preparing for future "global citizens." Each lesson is applied with the STEAM method, each game with the STEAM approach can give children different emotions, inspirations, and interests.

Through these game activities, 5-6-year-old preschoolers cannot only recognize scientific concepts but also understand structural features, materials, to make different project-based products. Preschool children need to experience, self-evaluate, and act on their own with an appropriate learning style based on their age so that they can achieve the

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educational goals set for this period to bring a happy future for children. Therefore, when designing games with the STEAM approach to developing children's capabilities, they must adhere to the principles and the step-by-step process so that each game brings useful knowledge and skills, joy, and fun surprises for them.

2. Results of research

2.1. Definition of "Game" with the STEAM approach

STEAM-based games are games that include Science, Technology, Engineering, Art, and Mathematics to guide children to learn, discuss, collaborate, and develop critical and creative thinking. These games have the following basic characteristics: (1) Clarity in the goal, ensuring the logic of science to the engineering, technology, arts of a product and produce a specific result; (2) Do not force children to remember enormous knowledge, but the purpose is to prepare students to develop capabilities for future generations of citizens; (3) To create opportunities for children to experience and stimulate the development of their senses and emotions; (4) Children truly get to play, and playing is the task of childhood; (5) Learn based on discovery and experience; (6) STEAM-based games develop freedom, self-dependence, self-controlling, emotions, creativity, and practicality for children; (7) Ensure the innocence and naturalness based on the psychology of preschoolers; and (8) Create a sense of happiness when they are satisfied with curiosity to explore the world around them (Nguyen, 2019).

The integrated perspective of life experience helps children develop their creativity, enable them to apply more of their acquired knowledge to real-life, and acquire problem-solving skills. Content design of STEAM-approach games to develop capabilities of 5-6-year-old preschool children should also follow the following three orientations (Aldemir & Kermani, 2017):

(1) Knowledge integration

Due to the advancement of technology, the acquisition and accumulation of knowledge is increasingly rapid and focused, yet causes disjointed discipline. To help children integrate knowledge easily, games are designed so that when children participate in the playing activities (games), they understand the correlation between knowledge and concepts in different STEAM fields.

(2) Experience practice

Games are designed to combine children's knowledge and life experience. Children can use their knowledge to solve problems in practice, boost the development of observation skills. For example, after the game, children can link the application of magnetic force in real-life, such as the compass.

(3) Develop problem-solving capabilities

When designing STEAM approach games, we need to pay attention to the situation and practical issues, with phenomena in social life. Playing these games will contribute to

boosting a child's ability to adapt to life, enabling them to perceive and practice solving social problems, practical problems that may be associated with the child personally, with local practices, or as global problems.

In order to design capabilities development games for preschool children between 5-6 years old with the STEAM approach, it is important to be aware of theoretical and practical bases such as (1) Jean Piaget's theory of cognitive development; (2) Vygotsky's Social Constructivists theory; (3) the objectives of comprehensive physical, cognitive, linguistic, aesthetic, social and emotional development for children between 5-6 years old in the Early Childhood Education Curriculum; standards and indicators specified in the 5-Year-old Child Development Standards; (4) the nurture and education plan implemented according to the daily living conditions; the distribution of time for the implementation of the Early Childhood Education Curriculum; (5) the unity in nurture and education of children between schools, families, and society; (6) the purpose of the game to develop comprehensive competence for children (Volosovez, Markova, Averin, 2019).

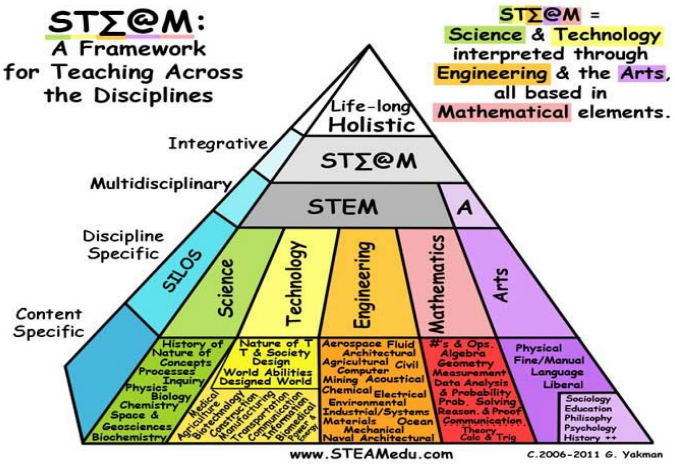

Figure 1. *STEAM- a Framework for Teaching Across the Disciplines*

2.2. Principles of STEAM-based game design for preschool children between 5-6 years old

2.2.1. Principles of meeting the pre-defined purposes

This principle requires the STEAM-based game design for 5-6 year old children to contribute to the goal of comprehensive capabilities development for children, ensure the content of topics and activities under the Early Childhood Education Curriculum to develop physically, awareness, language, aesthetics, socio-emotional, form the original elements of personality, prepare children for first grade, form and develop basic psychophysiology factors, competencies, and qualities, age-appropriate life skills, to boost and develop the most potential possibilities, create the foundation for learning at the next level of study and for lifelong learning.

By well implementing the above objectives when designing games, games should address

specific objectives such as developing scientific capabilities, technical capabilities, technology capabilities, mathematics capabilities, aesthetic – art capabilities for preschoolers between 5-6 years old (Using bloom cognitive scale to evaluate). Therefore, the goal of designing the game for preschoolers between 5-6 years old also means contributing more powerful forces to realizing the goals of the Early Childhood Education Curriculum.

The main purpose of the games is to develop the competencies needed for the work of the 21st century, including problem-solving capabilities, teamwork capabilities, critical thinking capabilities, creative thinking capabilities... The competencies are integrated according to different themes, are built systematically, continuously, and inherit each other...

2.2.2. Principles of comprehensiveness

The games are arranged from simple to complex, easy to difficult (in terms of game ideas, the game contents, the playing activities of the game, the game requirements) are gradually complicated, forming a system of games suitable for the characteristics of 5-6 year olds to help develop the capabilities for preschoolers between 5-6 years old. The games are designed to ensure the system of the content structure of the game itself, ensure the maximum development of the capabilities and personality qualities for children. The games should be designed and arranged into an open system in groups so that teachers can choose games, apply them flexibly and creatively to suit real conditions and circumstances, appropriate with the content of teaching children and their life experience.

2.2.3. Principles of development

This principle requires game designers be aware that development is a process that goes through many stages, from low to high, from simple to complex, from incomplete to complete. Each stage of the development has different characteristics, properties, and forms. Therefore, there must be specific analysis to find the appropriate game content and game topics to promote the development of the child. Therefore, the STEAM-based game design to develop the capabilities for children must comply with the rules of development, choice of goals, content, methods, means of organizing the game, from low to high, from simple to complex, to form and develop in the child positive capabilities, and to promote the ability to self-regulate. The game system aims to put children in a "Zone of proximal development" so that children can be creative in implementing the game idea, game content, and game activities. The games have a variety of levels of play to meet the child's various levels of awareness, movement, and experiences, to facilitate the development of attention, memory, thinking, imagination, communication skills, and the ability to communicate with friends, to enrich vocabulary, and to form coherent speech.

2.2.4. Principles to ensure the structure and properties of the game

By organizing fun activities to apply the STEAM model to daily activities for children in preschool, children experience creativity, know the fields of science close to life. Stimulate curiosity, scientific discovery, see very close scientific phenomena in daily life.

These games are supposed to give children interest, voluntarily participate in the game, actively apply their experience and performance ability to solve game tasks in lively playing situations with emulation and relay elements in accordance with the play characteristics of children between 5-6 years old.

Elements of the STEAM-based game should aim to enrich the symbolism of phenomenal things, develop cognitive and action skills, search, compare, analyze, categorize, criticize, have a positive attitude to explore the world around them, develop thinking skills, problem-solving skills, creativity, language ability, communication skills, create opportunities for children to develop social skills such as choice, decision-making, cooperation, sharing, and educate them the right attitude towards the life around them.

2.2.5. Principles of diversity

STEAM is one of the global educational trends, encompassing a learning environment that integrates five areas into a single development scheme for learners, facilitating and guiding children on how to apply science and art to everyday life. There are many games already available at home, in class. They will be s great tools to develop a child's creative and technical thinking. There are many other STEAM games for children that are easy to do by the hands of teachers and the children. Playing is the fastest way to attract and develop the imagination of children between 5-6 years old. Therefore, it is possible to select many toys that express all STEAM ideas for children. Such simple and smart toys will encourage even the smallest designers to invent, create, and dream.

2.2.6. Principles of popularity

Designing games that ensure popularity are games that have common characteristics and can be applied in various kindergartens of different localities. In other words, these are common games, often seen in many kindergartens, a big number of teachers know and can organize for the children at their schools to play. The STEAM based games for 5- 6year-olds must be designed in a way that is easy to use. Toys are easy to make andeasy to find. They can be used in educational conditions in different countries and localities. (Monkeviciene & Autukeviciene, 2019).

2.3. Game design process with STEAM approach

Design STEAM-based games to develop the capabilities of preschool children between 5-6 years old needs to follow the game structure, including:

Figure 2. *Design process of the STEAM based games*

2.3.1. Name the game

Name a game that fits the game task, game content, and triggers the desire of the children – to get interested in the game.

2.3.2. Determine the objectives of the game

When designing games, it is necessary to focus on identifying the goal of forming STEAM qualities and competencies. The objectives of the game should comply with the SMART principle (Specific, Measurable, Achievable, Realistic, and Time-Specific). These measurements are the basis for verifying the level of achievement of the goal of the game while helping teachers choose and build the right games. It is necessary to avoid general game objectives such as "understanding" "grasping" "usable". It is necessary to determine the desired capabilities development results that the child achieves after the end of the play session. The construction of the objectives of such games will help to design games with a very strict STEAM approach, ensuring the system, inheriting from previous games, as well as helping children to be bolder and more confident when making increasingly complex games.

The desired capabilities development results after playing a STEAM-based games usually include (1) Science: Developing, expanding, strengthening understanding of scientific concepts, practical issues.; (2) Technology: Developing skills to use computers and iPads to watch videos and games; (3) Engineering: Developing skills to create products from open materials; (4) Art: Know how to select and use the right materials for the game for a specific purpose; and (5) Mathematics: Developing the skill of counting numbers, measuring distances, heights, breadth of products (Monkeviciene & Autukeviciene, 2019).

2.3.3. Prepare toys, materials and means of play

a) Games using STEAM toy sets and various types of existing puzzle pieces

In the process of playing with STEAM toy sets, with STEAM puzzle pieces, robots, simple electronic devices to support the combination of playing and testing elements, preschoolers can learn the basics of modern robots, contributing to the development of technical creativity and formation of scientific and technical orientation in them. This also enables children to show initiative and independence, the ability to set goals, and cognitive actions.

Figure 3. *The basics of modern robots*

b) STEAM-based games using open materials

Many STEAM games can be played with materials, components, toys that are existing in the family, in the preschool classroom. This will be a great tool to develop the creative thinking and techniques of children, very easy to make by hand when using open materials, recycled materials, natural materials, available materials, take advantage of furniture, plastic, powders, paper, and carton covers. Open materials in daily life are a flexible way to recycle and reuse as items for fun games with the STEAM approach. For example, water, watercolor, soda powder, and salt can be used to your child's concept of size: height, width, and length. In addition, this material can be used for children to have fun at home. Such simple but smart toys will encourage even the smallest designers to invent, create, and dream. (Ona Monkeviciene (presenting/submitting), Birute Autukeviciene, 2019)

c) Playing/game environment

It is necessary to carefully consider the actual conditions of the playing environment such as playing space, toys, and game materials to design the game according to the appropriate STEAM approach: (1) The game organization space is flexible enough, large enough, safe to create an open, friendly atmosphere in the classroom; (2) Space for experiences with sufficient equipment, tools, materials for children to play; (3) It would be great if there is a separate STEAM classroom or a playground, a small corner dedicated for STEAM activities; (4) Children can play in a room or outdoors or in the park to make it easier to organize group activities. Promoting the ability to explore and apply in reality on their own so that children do not become too dependent on toys and materials. They will be

confidently active and capable; (6) A rich-material environment, which gives children the opportunity to participate in games (DeJarnette, 2018).

2.3.4. Determine the game content

Select content to design STEAM games following children's perceptions and discovery needs, suitable for activities, with the theme to mobilize the knowledge and skills that children already had in performing game activities, game tasks in the game. This aims at the "*near development area*" of the child. Pay attention to selecting anddesigning the game content that when participating in the game, children between 5-6 years old are satisfied with their curiosity, discovery, be able to learn about the world around them. Take into consideration the game situations, play activities using technological means, ensure the creativity of the game, ensure the emulation factor, elements of cooperation, support learning, research, exploring the world around children.

The action of playing (game activity) requires effort, perseverance to coordinate with your playmates to overcome some difficulties to complete the assigned task. Choose the right playing action for the ability to play, with the child's interest in playing and flexible playing in groups to ensure all advantages for children to agree to cooperate, have fun to play together. It is necessary to design play action/game activities for each play role that is easy to remember, attractive, and suitable for the needs, experiences, abilities, and interests of the child. Teachers are easy to organize game instructions, and children have freedom in the game after being guided.

Teachers can skillfully apply from integrating the use of different subjects to design games such as Science: Learning about scientific concepts, practical issues; Technology: Use a computer, iPad to watch videos related to projects, games or film the process of children performing games; Engineering: Making products from materials such as flowers, leaves, dried branches, wooden sticks in ice cream, straw, newspaper, nylon, glue, adhesive tape; Art: Selecting the right materials for the game for specific purposes, for example: making a home to protect chickens, creating new colors to decorate clothes, spring flowers; Mathematics: Count the number, measure the distance, height, width of the product, for example: measure the height, width of the swing that would be enough for two dolls, wagon for a family with parents and two children to go out, enough room to transfer the animals (specific number) to the zoo, count the number of layers of the cake. (Wood & Attfield, 2009).

2.3.5. Determine the game rules

Determining the rules of the game depends on the cognitive task, the play actions, the materials, toys, and the result of the game are meant to solve the problem. The rules of the game need to ensure attractiveness to promote positivity, freedom, children's voluntary participation in the games and to stimulate in children the need to explore.

2.3.6. Determine game evaluation criteria

Three criteria can be used to evaluate a child's play product as follows:

1) Creating product according to the teacher's request – Level 1
2) Creating the play product without the help of teachers or friends around them – Level 2
3) Being creative. Assess child's intentional creativity, creativity with a limited number of pieces, or creativity with the number of available free components – Level 3.

For example, in construction theme: "Track Curve" game, which can evaluate the creativity of children when building the track curve: straight, easy, difficult – like when changing the height of the curve, the ball will go at a faster speed; create elevators to transport different types of goods; use other pieces to create the track curve.

2.3.7. Direction of development and enhancement of the game

In the game, it is necessary to give suggestions for children to develop and enhance the game as if they can still use the existing materials in that topic. When designing games, it is necessary to pay attention to suggest children open material names and extended activities that are applicable in life to let children develop activities with toys and products that have just been completed. These extended-outside play activities are not limited to materials (DeJarnette, 2018).

3. Conclusion

In summary, the STEAM-based game design for preschoolers between 5-6 years old should adhere to six main principles: ensuring purposes, ensuring the comprehensiveness, ensuring the development, ensuring the structure and properties of the game, ensuring the diversity and popularity of the games, especially the principle of ensuring the game structure with the STEAM approach. Each game must ensure the full elements of the game with the STEAM approach and design according to the following process: (1) Name the game; (2) Determine the objectives of the game; (3) Preparation of means, time, and conditions; (4) Determining the game content of play; (5) Determining the game rules; (6) Determine game evaluation criteria; and (7) Game development direction.

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NGUYÊN TẮC VÀ QUY TRÌNH THIẾT KẾ TRÒ CHƠI CHO TRẺ MẪU GIÁO 5-6 TUỔI TẠI THÀNH PHỐ HỒ CHÍ MINH THEO CÁCH TIẾP CẬN STEAM

Nguyễn Thị Kim Anh[1*], Nguyễn Thị Thanh Bình[2], Nguyễn Thị Thanh[3]

[1]Viện Khoa học Giáo dục và Đào tạo giáo viên, Trường Đại học Quốc tế Hồng Bàng, Việt Nam

[2]Viện Nghiên cứu Giáo dục và Phát triển Kinh tế EXIM, Việt Nam

[3]Trường Đại học Sư phạm Thành phố Hồ Chí Minh, Việt Nam

[*]Tác giả liên hệ: Nguyễn Thị Kim Anh – Email: anhntk2@hiu.vn

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TÓM TẮT

Giáo dục STEAM (Khoa học, Công nghệ, Kĩ thuật, Nghệ thuật và Toán học) đã nhận được sự quan tâm ngày càng tăng trong thập kỉ qua, chủ yếu ở cấp tiểu học, trung học cơ sở và trung học phổ thông. Bài viết phân tích các khái niệm cơ bản như nguyên tắc, quy trình, thiết kế trò chơi. Bài viết đã xây dựng 6 nguyên tắc thiết kế cấu trúc trò chơi theo cách tiếp cận STEAM như: nguyên tắc đảm bảo tính mục đích, nguyên tắc đảm bảo tính hệ thống, nguyên tắc đảm bảo tính phát triển, nguyên tắc đảm bảo cấu trúc, tính đặc trưng của trò chơi, nguyên tắc đảm bảo tính đa dạng, nguyên tắc đảm bảo tính phổ biến. Đồng thời bài viết đã khái quát quy trình các bước thiết kế trò chơi cho trẻ 5-6 tuổi theo cách tiếp cận STEAM. Trên cơ sở này, giáo viên mầm non có thể thiết kế các trò chơi cho trẻ mẫu giáo 5-6 tuổi theo cách tiếp cận STEAM một cách hiệu quả và phù hợp với điều kiện thực tế.

Từ khóa: thiết kế trò chơi theo cách tiếp cận STEAM; nguyên tắc; quy trình